ELECTRICAL CONNECTOR

The present application claims priority to prior Japanese application JP 331045/2002, the disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION:

This invention relates to an electrical connector and, in particular, to an insulator in the electrical connector. The term "electrical connector" is merely referred to as "connector", hereinafter.

A known connector has an insulator, which comprises a holding portion for holding contact pins and a plate like portion formed integral with the holding portion. The plate like portion has inner and outer surfaces perpendicular to a first direction and is elongated in a second direction perpendicular to the first direction. The plate like portion is provided with a plurality of grooves, which are formed in the inner surface of the plate like portion. Each groove extends in a third direction perpendicular to the first and the second directions. The grooves are arranged in the second direction so that ridges are formed between the respective neighboring grooves in the second direction. In other words, the plate like portion has a cross section of square waves in a plane perpendicular to the third direction. The inner surface of the plate like portion faces the contact pins under the assembled state of the connector, and the grooves are positioned in correspondence with the respective contact pins held by the insulator.

An insulator having a complex shape as mentioned above is formed by an injection molding process, wherein anisotropic resin such as liquid crystal polymer is used as material of the insulator. The liquid crystal polymer is excellent in heat resistance and also has a property difficult to vary with time. On the other hand, because of its anisotropy, the liquid crystal polymer expands or contracts upon high temperature heating or cooling in accordance with alignment of the material.

There is one problem that an undesirable curve occurs at a molded insulator.

Because of the square-waves cross-section of the insulator, there is a large difference between expansion/contraction coefficients on the inner and the outer surfaces of the plate like portion. The expansion/contraction coefficient difference causes the undesirable curve of the insulator.

In addition, because of the elongated shape of the plate like portion, it is often difficult for resin to flow into a metal mold smoothly upon injection molding. As a result, residual stress might occur in the molded insulator. Such residual stress also causes the undesirable curve of the insulator.

SUMMARY OF THE INVENTION:

It is an object of the present invention to provide a connector having an insulator, wherein undesirable curves of the insulator are reduced.

The present invention is applicable to an electrical connector comprising an insulator and a plurality of contact pins held by the insulator. According to the present invention, the insulator comprises a base portion elongated in a first direction and having a thickness in a second direction perpendicular to the first direction and a height in a third direction perpendicular to the first and second directions. The insulator further

comprises a plate like portion, the plate like portion extending in the second direction from a top end of the base portion in the third direction and having first and second surfaces opposite to each other in the third direction. The plate like portion has a plurality of grooves formed in the first surface, the grooves extending in parallel with each other in the second direction and being spaced from each other in the first direction so that a plurality of ridges are formed between the respective neighboring ones of the grooves in the first direction. The contact pins are supported by the base portion and extend in the second direction along the grooves, respectively. The insulator is provided with a pattern on the second surface. The pattern comprises at least one depressed portion formed in the second surface and/or at least one raised portion formed on the second surface.

Preferred developments of the invention will be clarified below as the description proceeds.

BRIEF DESCRIPTION OF THE DRAWINGS:

Fig. 1 is a perspective view showing a connector according to a first embodiment of the present invention;

Fig. 2 is a perspective view showing the connector of Fig. 1, which is mounted on a circuit board;

Fig. 3 is a top plan view showing the connector of Fig. 1;

Fig. 4 is a front view showing the connector of Fig. 1;

Fig. 5 is a side view showing the connector of Fig. 1;

Fig. 6 is a cross-sectional view showing the connector of Fig. 3 or 4, taken along lines VI-VI;

Fig. 7 is a cross-sectional view showing the connector of Fig. 3 or 4, taken along lines VII-VII;

Fig. 8 is a perspective view of a ground plate;

Fig. 9 is a perspective view of a shell;

Fig.. 10 is a development of the shell shown in Fig. 9;

Fig. 11 is a perspective view showing an insulator included in the connector of Fig. 1;

Fig. 12 is a top plan view showing the insulator of Fig. 11;

Fig. 13 is a front view showing the insulator of Fig. 11;

Fig. 10 is a side view showing the insulator of Fig. 11;

Fig. 15 is a cross-sectional view showing the insulator of Fig. 12 or 9, taken along lines XV-XV;

Fig. 16 is a cross-sectional view schematically showing a plate like portion of the insulator of Fig. 15, taken along lines XVI-XVI;

Fig. 17 is a cross-sectional view showing a modification of the insulator of Fig. 15;

Fig. 18 is a cross-sectional view showing another modification of the insulator of Fig. 15;

Fig. 19 is a top plan view showing another modification of the insulator of Fig. 12;

Fig. 20 is a top plan view showing another modification of the insulator of Fig. 12;

Fig. 21 is a perspective view showing an insulator according to a second embodiment of the present invention;

Fig. 22 is a top plan view showing the insulator of Fig. 21;

Fig. 23 is a front view showing the insulator of Fig. 21;

Fig. 24 is a side view showing the insulator of Fig. 21;

Fig. 25 is a cross-sectional view showing the insulator of Fig. 22 or 19, taken along lines XXV-XXV;

Fig. 26 is a cross-sectional view schematically showing a plate like portion of the insulator of Fig. 25, taken along lines XXVI-XXVI;

Fig. 27 is a cross-sectional view showing a modification of the insulator of Fig. 25;

Fig. 28 is a cross-sectional view showing another modification of the insulator of Fig. 25;

Fig. 29 is a top plan view showing another modification of the insulator of Fig. 22;

Fig. 30 is a top plan view showing another modification of the insulator of Fig. 22;

Fig. 31 is a perspective view showing an insulator according to a third embodiment of the present invention;

Fig. 32 is a top plan view showing the insulator of Fig. 31;

Fig. 33 is a front view showing the insulator of Fig. 31;

Fig. 34 is a side view showing the insulator of Fig. 31;

Fig. 35 is a cross-sectional view showing the insulator of Fig. 32 or 29, taken along lines XXXV-XXXV;

Fig. 36 is a top plan view showing a modification of the insulator of Fig. 32;

Fig. 37 is a front view showing the insulator of Fig. 36;

Fig. 38 is a top plan view showing another modification of the insulator of Fig. 32;

Fig. 39 is a top plan view showing another modification of the insulator of Fig. 32;

Fig. 40 is a top plan view showing an insulator according to a fourth embodiment of the present invention;

Fig. 41 is a top plan view showing a modification of the insulator of Fig. 40; and

Fig. 42 is a top plan view showing another modification of the insulator of Fig. 40.

DESCRIPTION OF PREFERRED EMBODIMENTS:

With reference to Figs. 1 to 10, a connector 100 according to a first embodiment of the present invention comprises an insulator 10, a ground plate 20 having a plurality of ground contact pins 21, a plurality of signal contact pins 25, and a shell 30. The connector 100 of this embodiment is a receptacle connector, which is mounted on a circuit board 200, as shown in Fig. 2, within an electronic instrument such as an LCD (liquid crystal display). The connector can be mounted on a substrate within the electronic instrument. The connector 100 is connectable to a connector connected to an FPC (flexible printed circuit) or a connector connected to cables.

The connector 100 has an open end 101 in a Y-direction. The open end 101 can receive a fitting portion of a mating connector (not shown) when the connector 100 is mated with the mating connector. The ground contact pins 21 and the signal contact pins 25 are held by the insulator 10, as best shown in Figs. 6 and 7, so that the contact pins 21, 25 can be touched or accessed through the open end 101. The signal contact pins 25 are same with each other in the shape and arranged at regular intervals in the X-direction. The ground contact pins 21 are arranged at regular intervals in an X-direction perpendicular to the Y-direction. The shell 30 covers the insulator 10 for the sake of electrical noise shielding or the like.

Referring to Fig. 8, the ground plate 20 comprises a common plate 22 elongated in the X direction, ground pins 21 projecting from the common plate 22 and two ground terminals 23 projecting from opposite end portions of the common plate 22. The ground terminals 23 extend in the Y direction but opposite to the ground pins 21.

Referring to Figs. 9 and 10, the shell 30 is a rectangular tubular metallic member and comprises a top portion 31, opposite side portions 32,

and a lower portion 33. The shell 30 is further provided with two fixture portions 34 formed on the side portions 32 for fixing the connector 100 to the circuit board 200, and a plurality of engagement portions 35 projecting from the lower portion 33 for engaging with a base portion (11 in Figs. 6 and 7). The shell 30 is made of a metal plate by punching to form a metal blank 30' shown in Fig. 10, which blank 30' is then subjected to bending processes to bend along dotted lines shown in the figure to form the shell 30. In Fig. 10, same portions are shown by the same reference numerals as in Fig. 9. A front end portion of the lower portion 33 in Y direction is bent inwardly as a folded portion 36 as shown in Figs. 6 and 7.

With reference to Figs. 11 to 16, the insulator 10 is comprised of a base portion 11, a plate like portion 12, and side portions or blocks 13, which are formed integral with each other by an injection molding process using a liquid crystal polymer as a material. As seen from Figs. 6, 13, and 15, the base portion 11 supports the ground plate 30 with ground contact pins 21 and the signals contact pins 25, as mentioned above. The plate like portion 12 is connected to the base portion in a Z-direction perpendicular to the X- and the Y-directions. The side portions 13 are connected to the opposite sides of the plate like portion 12 in the X-direction, as shown in Figs. 11 to 14. The plate like portion 12 and the side portions 13 form a rectangular U-like shaped cross-section in a plane perpendicular to the Y-direction, i.e., in the XZ plane.

Referring to Figs. 1, 3, 4-5, and 7, the shell 30 is fit onto the insulator 10 so that the upper portion 31 overlying the supper surface of the plate like portion 12, the side portions 32 overlying outer surfaces of the side blocks 13 and the lower portion 33 extending between the side portions 13. The lower portion 33 facing the lower surface of the plate like portion 12 but being spaced therefrom also from the signal contact pins

25. The ground contact pins 21 extend along the lower portion 33 of the shell 30.

As shown in Fig. 15, the plate like portion 12 has upper and lower surfaces 12a, 12b in the Z-direction. In this embodiment, the upper and the lower surfaces 12a, 12b are substantially perpendicular to the Z-direction so that the plate like portion 12 has generally a flat plate like shape, as seen from Fig. 11. As shown in Figs. 11 to 13, the plate like portion 12 is elongated in the X-direction.

As shown in Figs. 11, 13 and 16, a plurality of grooves 14 is formed in the lower surface 12b of the plate like portion12. Each of the grooves 14 extends and is elongated in the Y-direction. The grooves 14 are arranged in the X-direction so that ridges 15 are formed between the respective neighboring grooves 14 in the X-direction. The grooves 14 and the ridges 15 form a cross section of continuous square waves, as shown in Figs. 13 and 16.

As shown in Figs. 11, 12, 15 and 16, the insulator 10 according to the present embodiment is further provided with a plurality of material-depressed portions 16 in the upper surface 12a of the plate like portion 12. Each of the material-depressed portions 16 is a rectangular recess extending in the Y-direction, as best shown in Fig. 12. In other words, each of the material-depressed portions 16 is elongated in the Y-direction and has a shape longer in the Y-direction than in the X-direction. In this embodiment, each of the material-depressed portions 16 has a constant depth, as shown in Fig. 15. In addition, each of the material-depressed portions 16 does not reach front and rear edges 12c, 12d of the plate like portion 12 in the Y-direction.

The material-depressed portions 16 are positioned in correspondence with the respective ridges 15, as best shown in Figs. 15 and

16. The material-depressed portions 16 are arranged in the X-direction, similar to the ridges 15 of the lower surface 12b of the plate like portion 12. By the provision of the material-depressed portions 16 on the upper surface 12a of the plate like portion 12, similar waves are formed in the upper and the lower surfaces 12a, 12b, as shown in Fig. 16, so that the difference between expansion/contraction coefficients on the upper and the lower surfaces 12a, 12b of the plate like portion 12 can be made as small as possible. Therefore, according to the present embodiment, the undesirable curves can be reduced.

Various modifications and embodiments will be described hereinbelow with reference to Figs. 17-42. However, similar ground plate 20, similar signal contact pins 25, and similar shell 30 can be used and combined with the insulator in the similar manner as described with reference to Figs. 1-16. Accordingly, description of them will be omitted for the simplification of the description and the drawings.

The material-depressed portions 16 may be modified as material-depressed portions 16a, as shown in Fig. 17. The illustrated material-depressed portion 16a is comprised of two sections 16a1, 16a2. The sections 16a1, 16a2 constituting one material-depressed portion 16a are arranged on a single imaginary line extending in the Y-direction. The section 16a1 has a depth different from another depth of the second 16a2. Specifically, the section 16a1 nearer to the front edge 12c of the plate like portion 12 is deeper than the section 16a2 nearer to the rear edge 12d of the plate like portion 12. In other words, the material-depressed portion 16a has stepwise-increased depths towards the front edge 12c to the plate like portion 12. The material-depressed portion 16a may have a continuously-increased depth towards the front edge 12c of the plate like portion 12.

The material-depressed portions 16 further may be modified as material-depressed portions 16b, as shown in Fig. 18. The illustrated material-depressed portion 16b is comprised of two sections 16b1, 16b2. Similar to the material-depressed portion 16a of Fig. 17, the sections 16b1, 16b2 constituting one material-depressed portion 16b are arranged on a single imaginary line extending in the Y-direction. In addition, the section 16b1 is separated and spaced from the section 16b2 in the Y-direction. The section 16b1 has a depth different from another depth of the second 16b2. The section 16b1 has a constant depth, while the section 16b2 has another constant depth. Each section 16b1, 16b2 may have stepwise-increased depths towards the front edge 12c of the plate like portion 12, or may have a continuously-increased depth towards the front edge 12c of the plate like portion 12.

As seen from Fig. 12 and Fig. 19 or 16, the material-depressed portions 16 may be formed in the upper surface 12a of the plate like portion 12 so that the material-depressed portions 16 correspond not to all of the ridges but to the regularly-selected ones of the ridges of the lower surface of the plate like portion 12. The decreased material-depressed portions 16 in comparison with Fig. 12 are shown with broken lines in Fig. 19 or 16. In the insulator shown in Fig. 19, one material-depressed portion is decreased for each three material-depressed portions 16 of Fig. 12. In the insulator shown in Fig. 20, two material-depressed portions are decreased for each three material-depressed portions 16 of Fig. 12.

With reference to Figs. 21 to 26, an insulator according to a second embodiment of the present invention has a similar structure to the first embodiment. Only the differences between the first and the second embodiments will be explained below.

As shown in Figs. 21, 22, and 24 to 26, the insulator 10 according to the second embodiment comprises a plurality of material-raised portions 17 instead of the material-depressed portions 16 of the first embodiment. Each of the material-raised portions 17 extends and is elongated in the Y-direction and has a cross-section shaped like the Inter City Express or the Shinkansen, wherein the cross-section is comprised of two parts: a slantingly-rising part 17_1 and a constant part 17_2 continuing from the slantingly-rising part 17_1. The slantingly-rising part 17_1 is positioned nearer to the front edge 12c of the plate like portion 12 than the constant part 17_2 in the Y-direction. Each of the material-raised portions 17 generally has a shape longer in the Y-direction than in the X-direction. In this embodiment, each of the material-raised portions 16 does not reach front and rear edges 12c, 12d of the plate like portion 12 in the Y-direction.

The material-raised portions 17 are positioned in correspondence with the respective grooves 14, as best shown in Figs. 25 and 26. The material-raised portions 17 are arranged in the X-direction, similar to the grooves 14 of the lower surface 12b of the plate like portion 12. By the provision of the material-raised portions 17 on the upper surface 12a of the plate like portion 12, similar waves are formed in the upper and the lower surfaces 12a, 12b, as shown in Fig. 26, so that the present embodiment can provide the same effect as the first embodiment.

The material-raised portions 17 may be modified as material-raised portions 17a, as shown in Fig. 27. The illustrated material-raised portion 17a is comprised of two sections 17a1, 17a2. The sections 17a1, 17a2 constituting one material-raised portion 17a are arranged on a single imaginary line extending in the Y-direction. Each of the sections 17a1, 17a2 has a similar cross section to the material-raised portion 17. However, the section 17a1 has a height different from another height of the

second 17a2. Specifically, the section 17a1 nearer to the front edge 12c of the plate like portion 12 is lower than the section 17a2 nearer to the rear edge 12d of the plate like portion 12. The material-raised portion 17a may have a continuously-decreased height towards the front edge 12c of the plate like portion 12.

The material-raised portions 17 further may be modified as material-raised portions 17b, as shown in Fig. 28. The illustrated material-depressed portion 17b is comprised of two sections 17b1, 17b2. Similar to the material-raised portion 17a of Fig. 27, the sections 17b1, 17b2 constituting one material-depressed portion 17b are arranged on a single imaginary line extending in the Y-direction. In addition, the section 17b1 is separated and spaced from the section 17b2 in the Y-direction. The section 17b1 has a height lower than another height of the second 17b2.

As seen from Fig. 22 and Fig. 29 or 26, the material-raised portions 17 may be formed in the upper surface 12a of the plate like portion 12 so that the material-raised portions 17 correspond not to all of the grooves but to the regularly-selected ones of the grooves of the lower surface of the plate like portion 12. The decreased material-raised portions 17 in comparison with Fig. 22 are shown with broken lines in Fig. 29 or 26. In the insulator shown in Fig. 29, one material-raised portion is decreased for each three material-raised portions 17 of Fig. 22. In the insulator shown in Fig. 30, two material-raised portions are decreased for each three material-raised portions 17 of Fig. 22.

The plate like portion 12 of the insulator 10 may have the material-depressed portions 16 according to the first embodiment and the material-raised portions 17 according to the second embodiment. That is, the first embodiment may be conceptually combined with the second embodiment.

With reference to Figs. 31 to 35, a third embodiment of the present invention adopts an alternative approach to the first and the second embodiments, so as to suppress the occurrence of the undesirable curves. In this embodiment, the resin is flowed into a metal mold along the X-direction when the insulator 10 elongated in the X-direction is manufactured. If a material-increased portion 18 extending in the X-direction (i.e. a resin-flowing direction) is provided for the plate like portion 12, it becomes easy for resin to flow into a metal mold smoothly upon injection molding. As a result, residual stress is reduced so that the occurrence of the undesirable curves is suppressed.

The illustrated material-increased portion 18 is a single portion which is laid over all of the grooves 14 and the ridges 15 in the X-direction. The material-increased portion 18 is formed on the upper surface 12a of the plate like portion 12 of the insulator 10. The material-increased portion 18 has a thin, rectangular shape which is elongated in the X-direction. The material-increased portion 18 does not reach the front and the rear edges 12c, 12d of the plate like portion 12 in the Y-direction.

The single integrally-formed material-increased portion 18 may be modified as a material-increased portion 18a, as shown in Figs. 36 and 37. The material-increased portion 18a is comprised of two sections 18a1, 18a2. Each of the sections 18a1, 18a2 is elongated in the X-direction so that the section 18a1, 18a2 has a shape longer in the X-direction than in the Y-direction. The sections 18a1, 18a2 are arranged in the X-direction and are spaced from each other in the X-direction.

Also, the material-increased portion 18 may be modified as a material-increased portion 18b, as shown in Fig. 38. The material-increased portion 18b is comprised of two sections 18b1, 18b2. Each of the sections 18b1, 18b2 is elongated in the X-direction so that the section

18b1, 18b2 has a shape longer in the X-direction than in the Y-direction. The sections 18b1, 18b2 are arranged not in the X-direction but in the Y-direction so that the sections 18b1, 18b2 are spaced from each other in the Y-direction.

Furthermore, the material-increased portion 18 may be modified as a material-increased portion 18c, as shown in Fig. 39. The material-increased portion 18c is comprised of six sections 18c1 to 18c6. Each of the sections 18c1 to 18c6 is elongated in the X-direction so that it has a shape longer in the X-direction than in the Y-direction. The sections 18c1, 18c2 are arranged in the Y-direction. The sections 18c3, 18c4 are also arranged in the Y-direction. The sections 18c5, 18c6 are alto arranged in the Y-direction. The sections 18c1, 18c3, 18c5 are arranged in the X-direction. Likewise, the sections 18c2, 18c4, 18c6 are arranged in the X-direction. The sections 18c1 to 18c6 are separated from each other in accordance with the arrangements thereof.

The plate like portion 12 of the insulator 10 may have the material-depressed portions 16 according to the first embodiment and the material-increased portions 18 according to the third embodiment. That is, the first embodiment may be conceptually combined with the third embodiment. Figs. 40 to 42 show various combinations of the first and the third embodiments.

The insulator 10 shown in Fig. 40 is provided with four material-depressed portions 16c and two pairs of material-increased portions 18d. The material-increased portions 18d are formed on the upper surface 12a of the plate like portion 12. The material-depressed portions 16c are formed in the upper surface 12a of the plate like portion 12. Each of the material-increased portions 18d is elongated in the X-direction, while each of the material-depressed portions 16c is elongated in the Y-direction. All of the

material-depressed portions 16c are positioned between the pairs of the material-increased portions 18d in the X-direction.

The insulator 10 shown in Fig. 41 is provided with two sets of six material-depressed portions 16c and two material-increased portions 18d. The material-increased portions 18d are formed on the upper surface 12a of the plate like portion 12. All of the material-increased portions 18d are positioned between the sets of the material-depressed portions 16c in the X-direction.

The insulator 10 shown in Fig. 42 is provided with three sets of a material-increased portion 18d and six material-depressed portions 16d. Each of the material-depressed portions 16d is elongated in the Y-direction. The opposite sets of the material-increased portion 18d and the material-depressed portions 16d have the same arrangements as each other. The middle set of the material-increased portion 18d and the material-depressed portions 16d has the reverse arrangement of the opposite sets. That is, on the upper surface 12a of the plate like portion shown in Fig. 42, a plurality of sets are arranged in alternate arrangements, wherein each of the sets comprises the material-increased portion(s) 18d and a plurality of the material-depressed portions 16d.